

Southern California regional earthquake probability estimated from continuous GPS data

Greg Anderson
USGS Pasadena

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Outline

- Motivation
- Velocity field estimation
- Regional strain rate estimation
- Strain rate \longrightarrow moment rate density (\dot{M}_0)
- Future: $\dot{M}_0 \longrightarrow$ earthquake rates

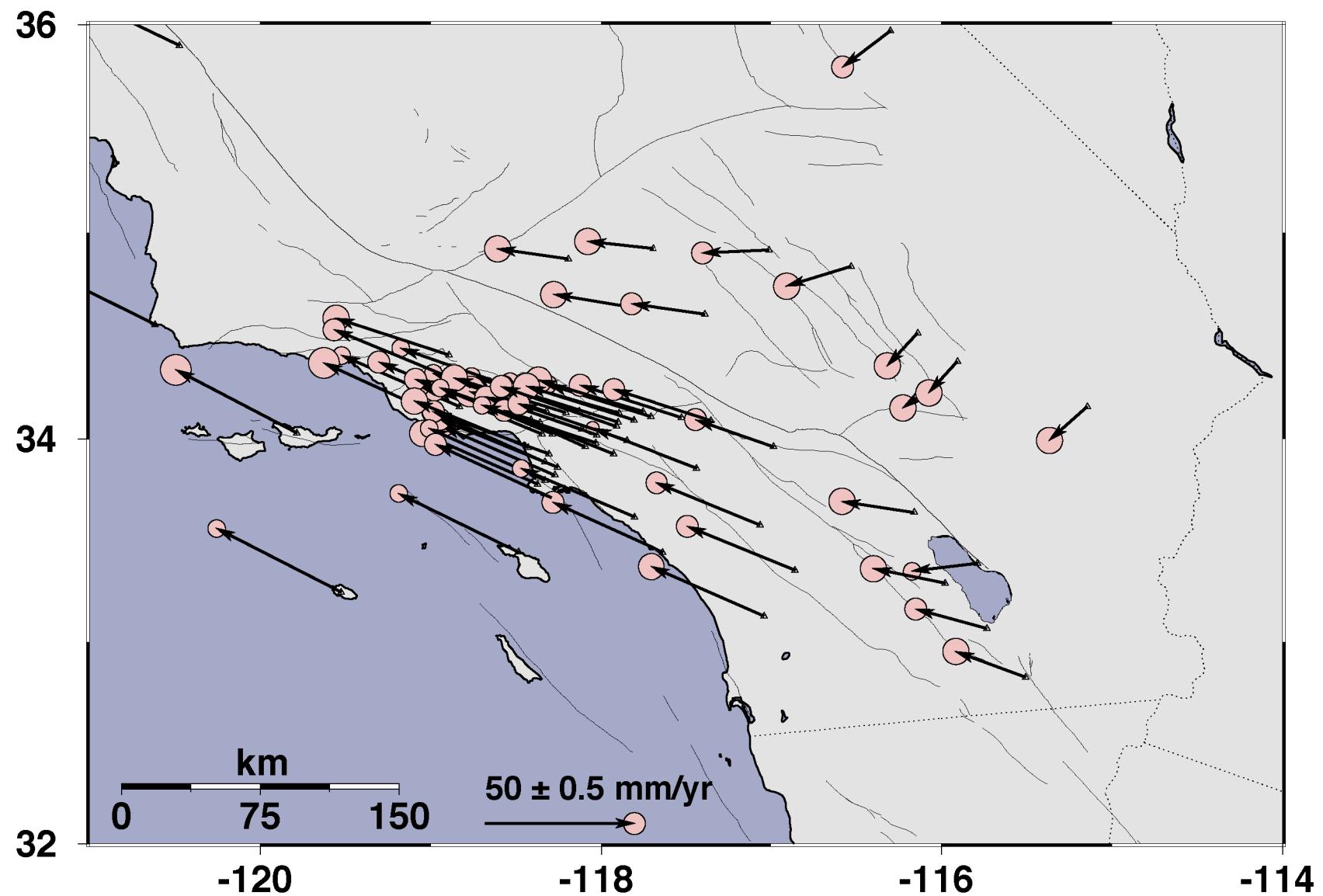
Motivation

- Current seismic hazard estimates:
seismic & geologic data
- Geodetic models also useful
Particularly if fault slip poorly-constrained
Well-defined error estimates
- USGS long-term plan: include geodetic data
in future US national seismic hazard maps

Estimate geodetic velocities

- ITRF2000 SCIGN station positions from SOPAC
- Fit position series with linear model
- Error model: white noise + random walk
- Best 83 stations:
RMS misfit < 2 mm, > 700 days data

Selected SCIGN Velocities



Velocities $\longrightarrow \dot{\epsilon}_i$

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 - Distance: $\exp(-R^2/2D^2)$, D adjustable

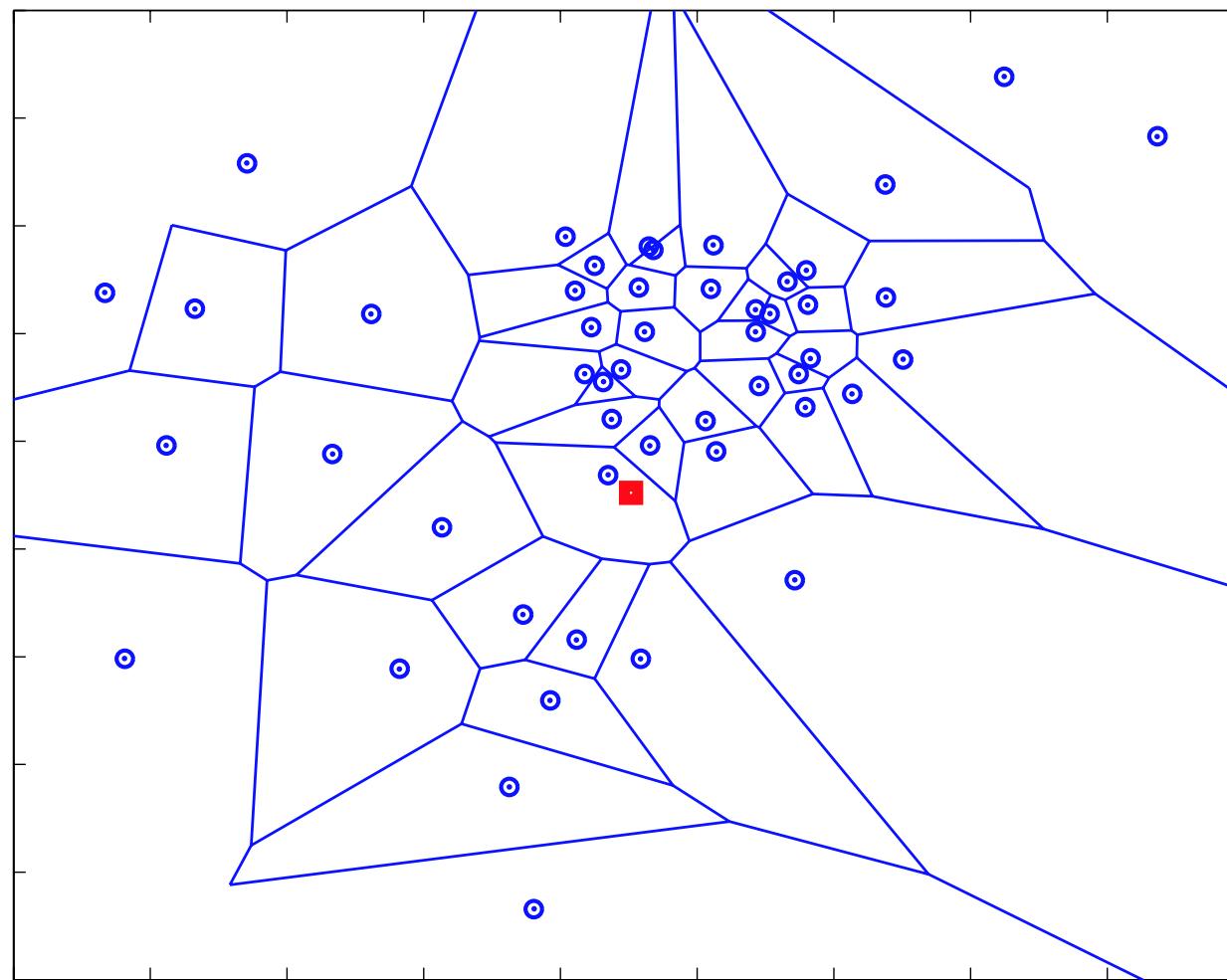
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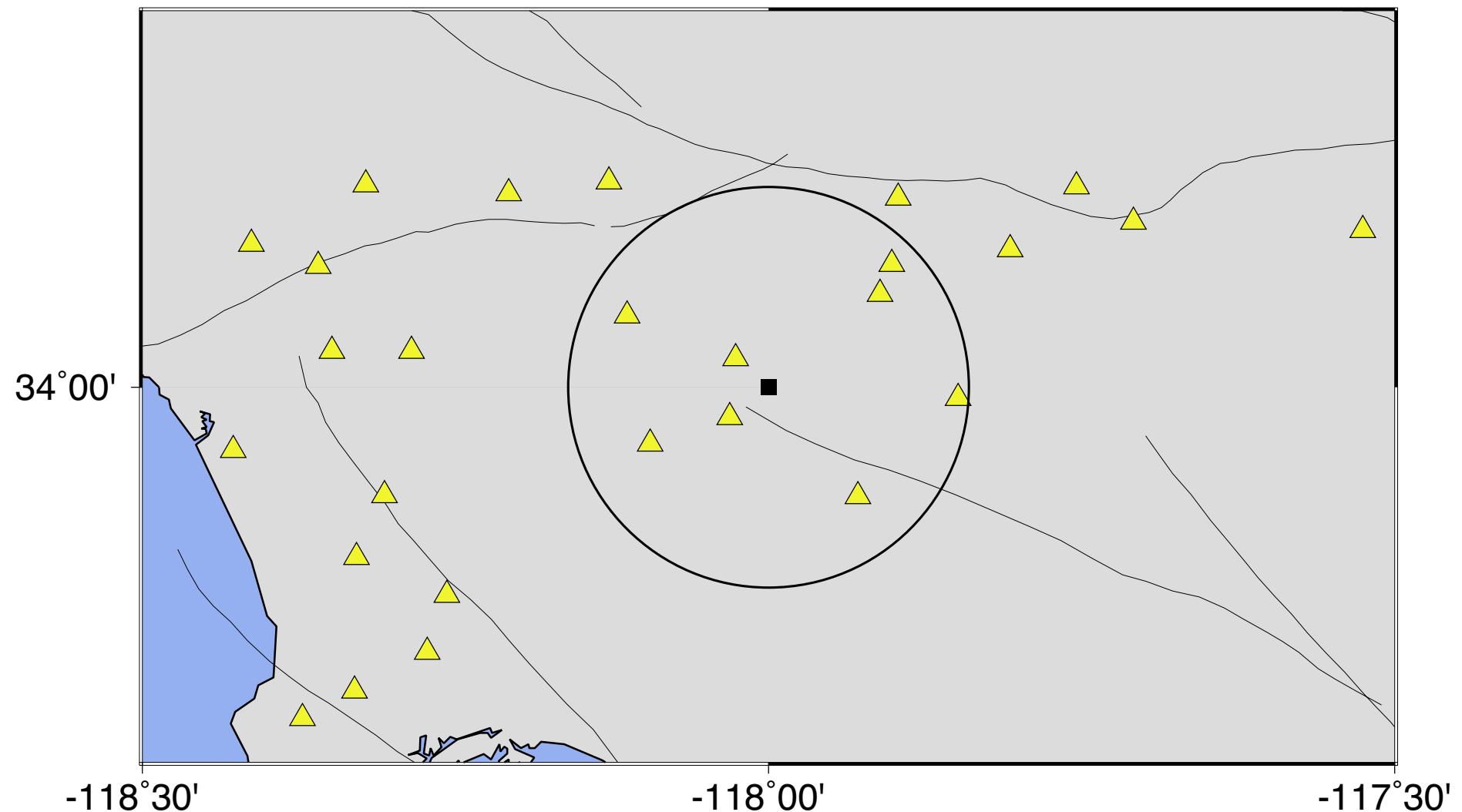
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 - Station distribution: Voronoi cell area

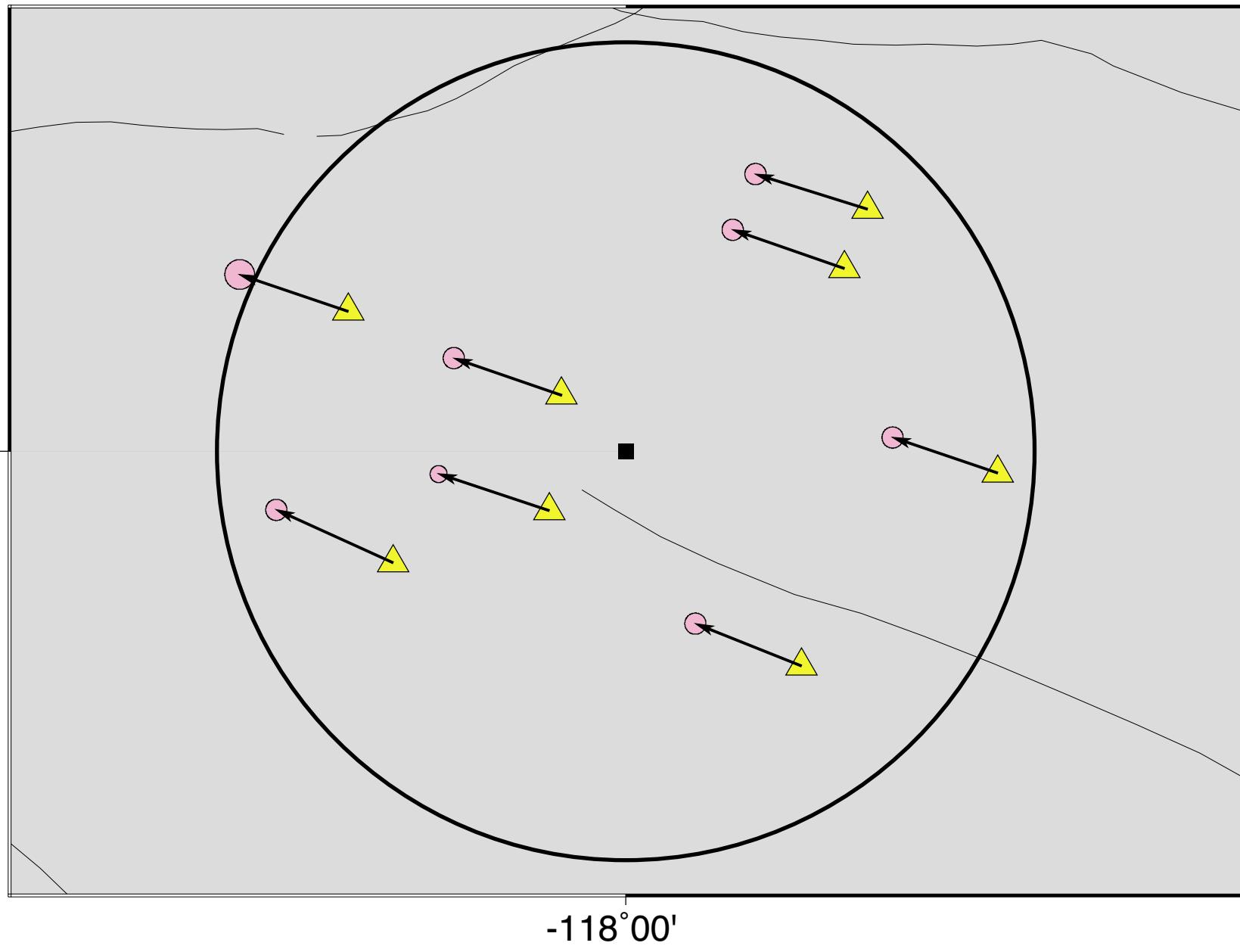
Voronoi Cells



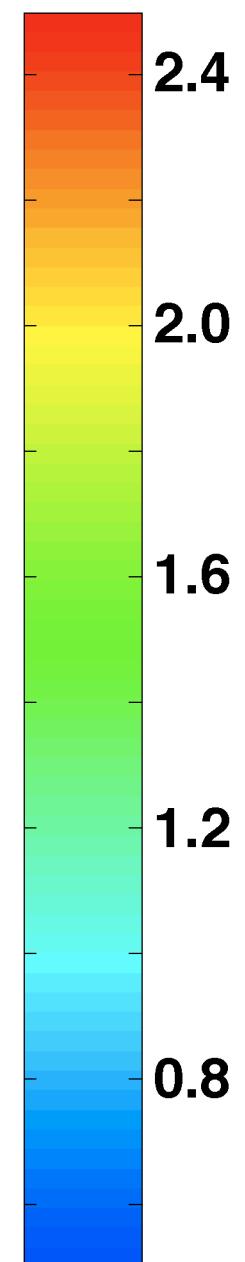
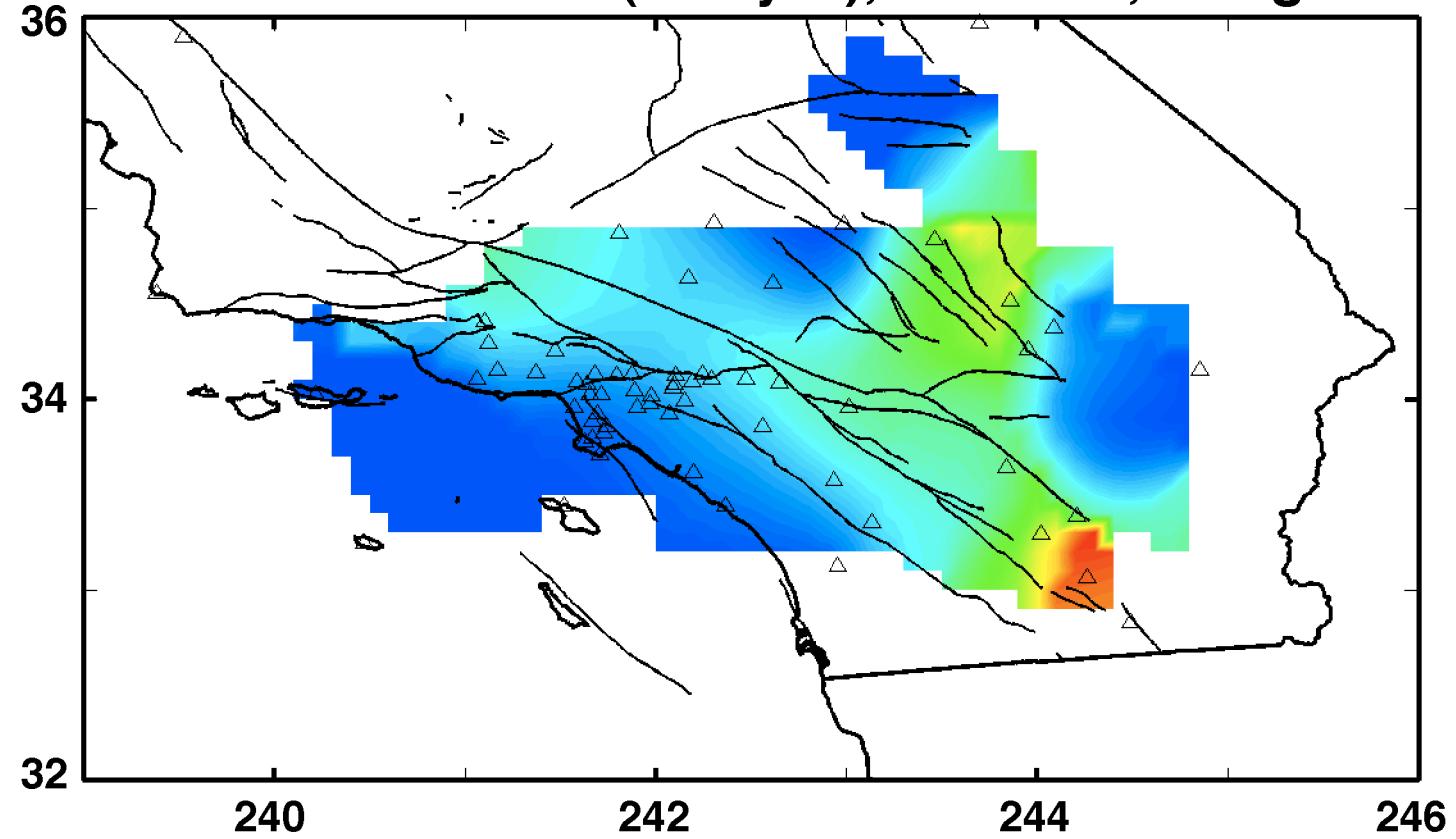
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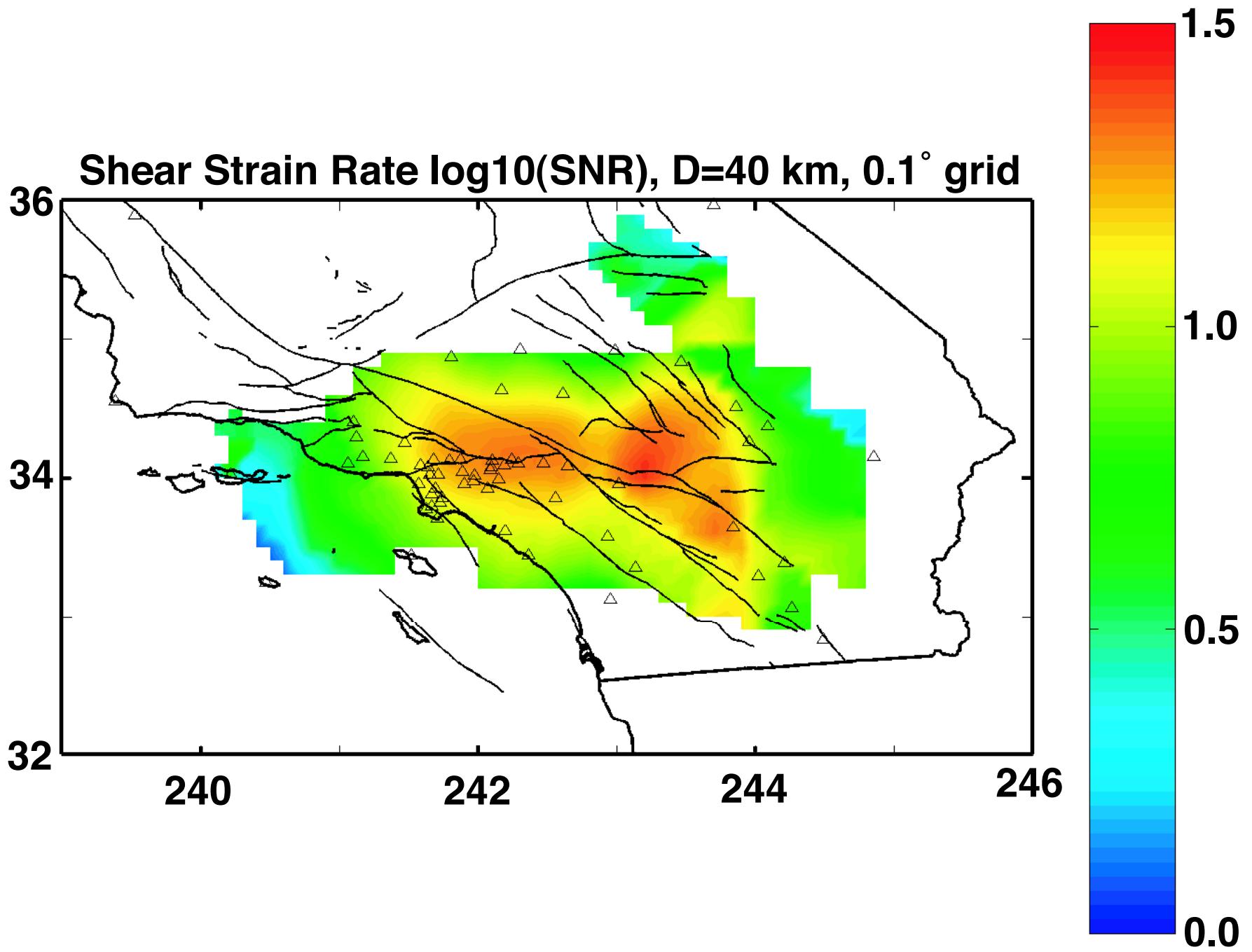
- For i^{th} grid node:
all geodetic velocities + weights $\longrightarrow \dot{\epsilon}_i$
Bootstrap $\dot{\epsilon}_i$ errors
- Weights:
 - Distance: $\exp(-R^2/2D^2)$, D adjustable
 - Data uncertainties: $1/\sigma$
 - Station distribution: Voronoi cell area
- Result: $\dot{\epsilon}_i$ & bootstrap errors





Shear Strain Rate (10^{-7} yr^{-1}), D=40 km, 0.1° grid





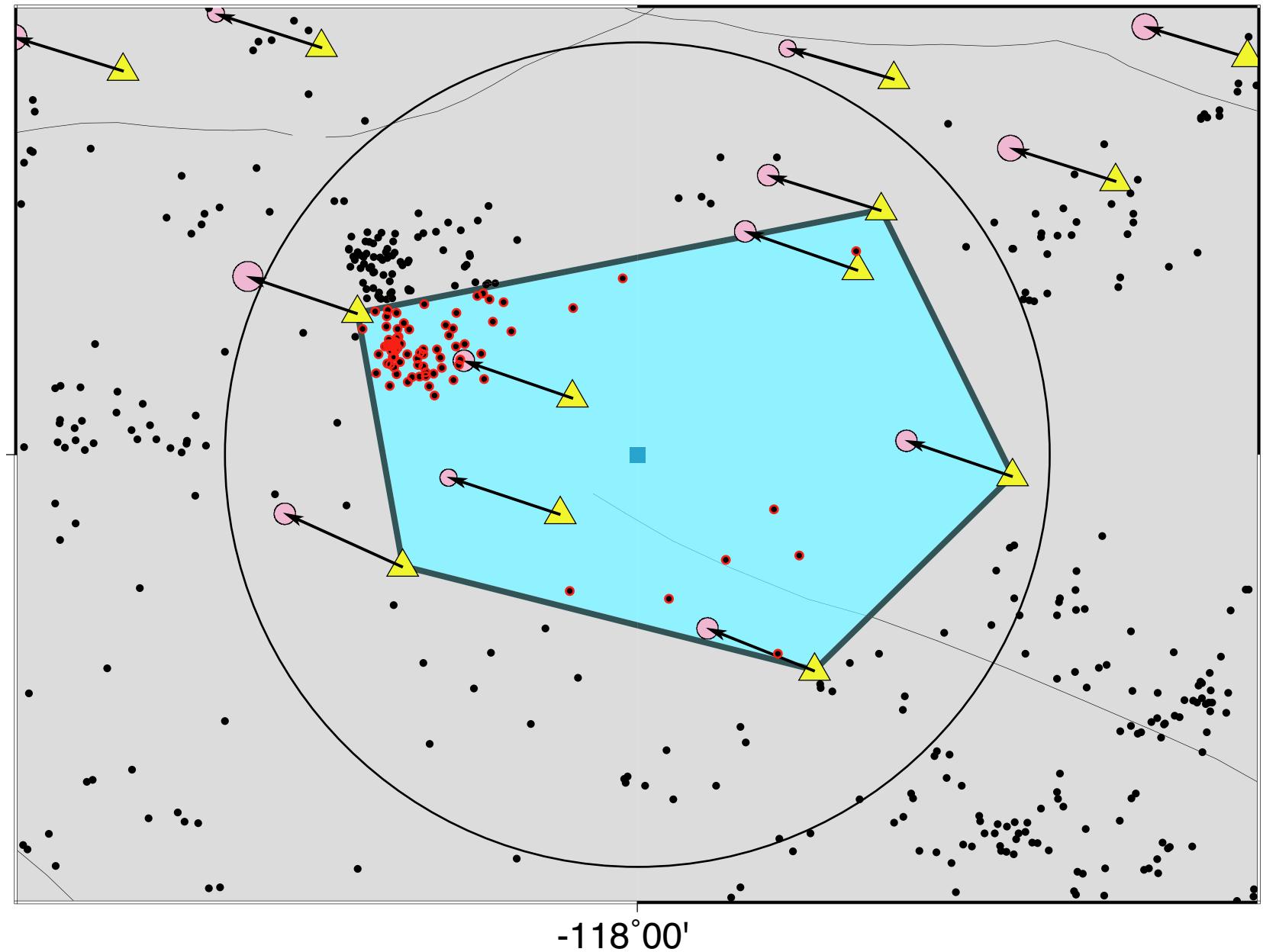
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- Ward, Hsu & Simons: $\dot{\epsilon}_i$

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- Seismogenic thickness: H_i

H_i = Depth Range of 95% of Red Earthquakes



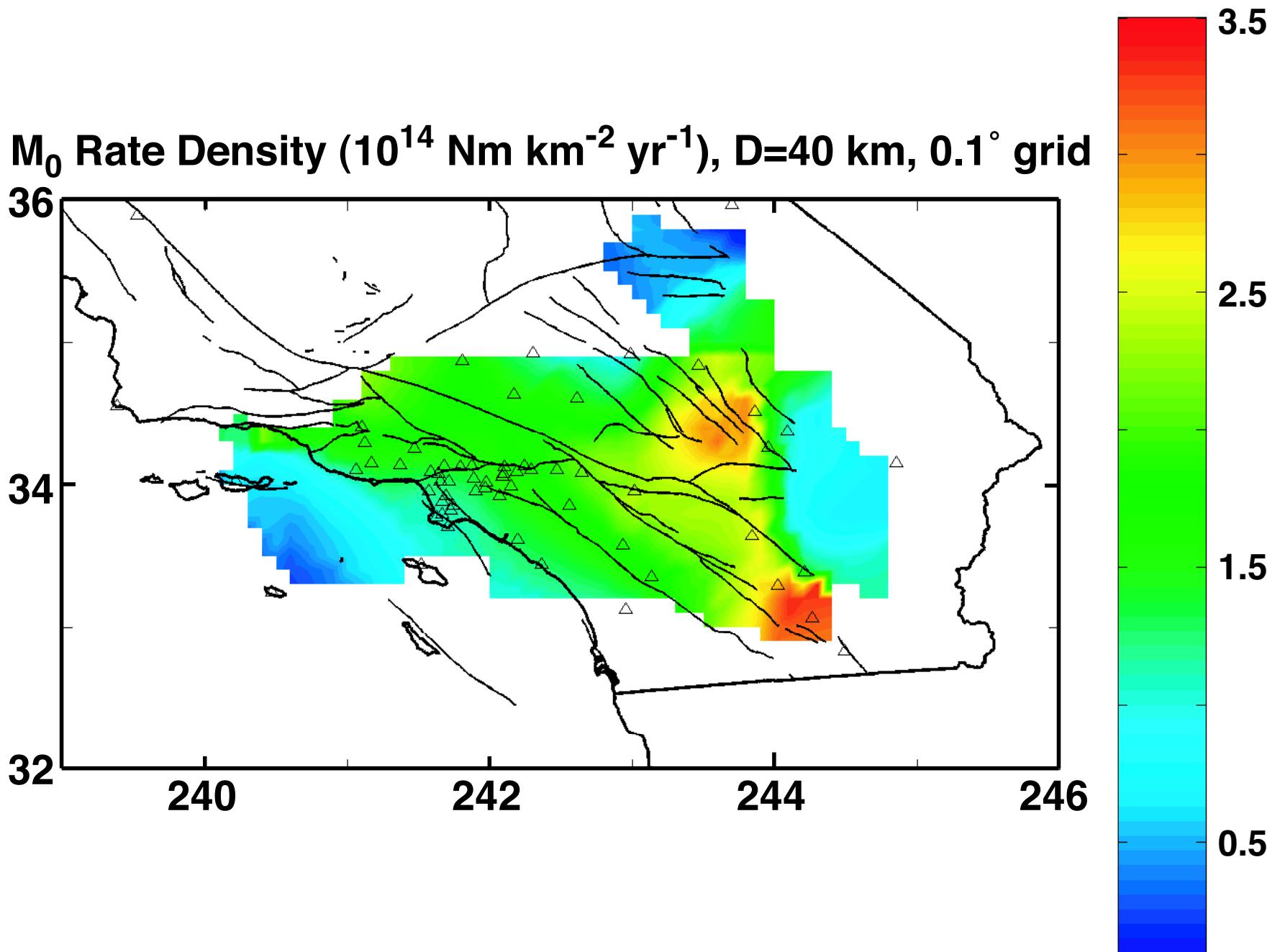
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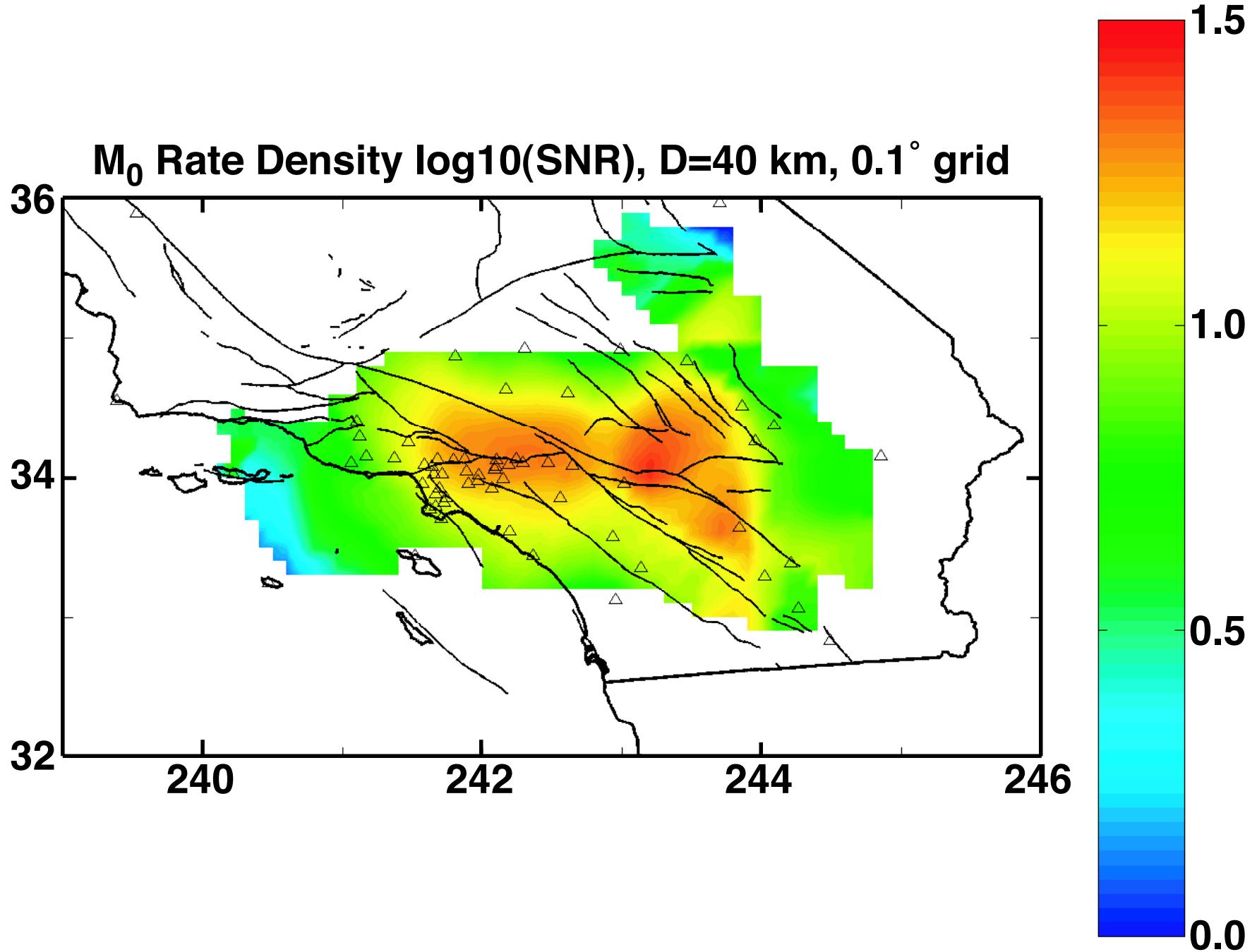
- Hsu & Simons: $\dot{\epsilon}_i$
- Seismogenic thickness: H_i
- Savage & Simpson moment rate density:

$$\dot{M}_0^i = 2\mu H_i \operatorname{Max}(|\epsilon_1^i|, |\epsilon_2^i|, |\epsilon_1^i + \epsilon_2^i|)$$

μ : rigidity

$\epsilon_1^i, \epsilon_2^i$: principal strain rates for i^{th} node





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- Yaru Hsu and Mark Simons for sharing their code and answering questions
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